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CRITICAL SUCCESS FACTORS OF BI PROJECT IMPLEMENTATION: AN IMPLEMENTATION METHODOLOGY PERSPECTIVE

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ABSTRACT

Aim/Purpose	The purpose of this paper is to identify Critical Success Factors (CSFs) for Business Intelligence (BI) implementation projects by studying the existing BI project implementation methodologies and to compare these methodologies based on the identified CSFs.
Background	The implementation of BI project has become one of the most important technological and organizational innovations in modern organizations. The BI project implementation methodology provides a framework for demonstrating knowledge, ideas and structural techniques. It is defined as a set of instructions and rules for implementing BI projects. Identifying CSFs of BI implementation project can help the project team to concentrate on solving prior issues and needed resources.
Methodology	Firstly, the literature review was conducted to find the existing BI project implementation methodologies. Secondly, the content of the 13 BI project implementation methodologies was analyzed by using thematic analysis method. Thirdly, for examining the validation of the 20 identified CSFs, two questionnaires were distributed among BI experts. The gathered data of the first questionnaire was analyzed by content validity ratio (CVR) and 11 of 20 CSFs were accepted as a result. The gathered data of the second questionnaire was analyzed by fuzzy Delphi method and the results were the same as CVR. Finally, 13 raised BI project implementation methodologies were compared based on the 11 validated CSFs.

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Contribution	This paper contributes to the current theory and practice by identifying a complete list of CSFs for BI projects implementation; comparison of existing BI project implementation methodologies; determining the completeness degree of existing BI project implementation methodologies and introducing more complete ones; and finding the new CSF "Expert assessment of business readiness for successful implementation of BI project" that was not expressed in previous studies.
Findings	The CSFs that should be considered in a BI project implementation include: "Obvious BI strategy and vision", "Business requirements definition", "Business readiness assessment", "BI performance assessment", "Establishing BI alignment with business goals", "Management support", "IT support for BI", "Creating data resources and source data quality", "Installation and integration BI programs", "BI system testing", and "BI system support and maintenance". Also, all the 13 BI project implementation methodologies can be divided into four groups based on their completeness degree.
Recommendations for Practitioners	The results can be used to plan BI project implementation and help improve the way of BI project implementation in the organizations. It can be used to reduce the failure rate of BI implementation projects. Furthermore, the 11 identified CSFs can give a better understanding of the BI project implementation methodologies.
Future Research	Future researchers may add other BI project implementation methodologies and repeat this research. Also, they can divide CSFs into three categories including required before BI project implementation, required during BI project implementation and required after BI project implementation. Moreover, researchers can rank the BI project implementation CSFs. As well, Critical Failure Factors (CFFs) need to be explored by studying the failed implementations of BI projects. The identified CSFs probably affect each other. So, studying the relationship between them can be a topic for future research.
Keywords	business intelligence, business intelligence project implementation, business intelligence implementation methodologies, Fuzzy Delphi method, critical success factors (CSF)

INTRODUCTION

The large amount of data generated in the daily operations of organizations provides an opportunity to understand issues better and improve efficiency and effectiveness. For this purpose, organizations must have data warehouse (DW) and business intelligence (BI) capabilities (Mueller, 2013). The term BI refers to technologies, applications and practices for the collection, integration, analysis, and presentation of business information (Balachandran & Prasad, 2017; Negash & Gray, 2008). BI is a concept which includes a set of techniques and methods that aims to configure a high-level tool to support the decision makers (Bara et al., 2009; Safwan et al., 2016; Yasser & Zota, 2016). The annual *SIM IT Issues and Trends Study* reported that BI was the largest organizational IT investment in 2015 (Arnott et al., 2017).

Although many organizations embark on projects to implement BI, their implementation is not always successful (Eybers, 2015; Lukić et al., 2016; Nguyen et al., 2018). It is generally believed that the implementation of BI is not a conventional application-based IT project (such as an operational or transactional system) (Bara et al., 2009; Larson & Chang, 2016; Yeoh & Koronios, 2010). Reports indicate the high risk and high failure rates of BI project implementation in organizations (Azeroual & Theel, 2019; Eybers, 2015; Pham et al., 2016; Villamarín-Garcia & Pinzón, 2017). According to Gart-

ner Inc., about 70% to 80% of BI projects fail. Pham et al. (2016) estimated a rate of failure approximately between 65% and 70%. Those failures produce problems within organizations such as wasted resources, time, and costs opportunity of invested capital, as well as an inability to achieve expected benefits (Pham et al., 2016; Villamarín-Garcia & Pinzón, 2017).

One reason for the failure is the incorrect methodology chosen by the organizations to implement BI project (Arizmendi & Stapleton, 2019; Tian et al., 2015). The methodology provides a framework for demonstrating knowledge, ideas and structural techniques for the deployment process. It can be defined as a set of instructions and rules that are used in each stage of the process (Yasser & Zota, 2016). BI implementation methodologies are one of the most important aspects of successful implementation of BI projects that have received little attention. With the data landscape changing so rapidly, BI projects and the used implementation methodologies are also changing (Larson & Chang, 2016). However, to manage the implementation of a BI project efficiently in this highly complex environment, a methodology should be carefully chosen (Lukić et al., 2016; Olszak & Ziemba, 2007; Thomann & Wells, 2000). Each of the existing BI project implementation methodologies has its own characteristics, strengths and weaknesses (Sen & Sinha, 2005; Yasser & Zota, 2016). As BI is newly introduced, there is not a standard methodology for its implementation (Aruldoss et al., 2014; Kimball et al., 1998; Lukić et al., 2016; Sen & Sinha, 2005). Therefore, an important question that managers are faced with is about the best methodology for successful implementation of BI project (Sen & Sinha, 2005).

Understanding the critical success factors (CSFs) of the BI project implementation is essential for a company to succeed in implementing a BI project (El-Adaileh & Foster, 2019; Pham et al., 2016). CSFs were introduced by Rockart (1979) and the MIT Sloan School of Management as a way to help senior executives define their information needs for the purpose of managing their organizations. CSFs "are the few key areas of activity in which favorable results are absolutely necessary for a particular manager to reach his goals. Because these areas of activity are critical, the manager should have the appropriate information to allow him to determine whether events are proceeding sufficiently well in each area" (Bullen & Rockart, 1981, p.3).

Although the application of BI has increased, the CSFs that should be considered in implementing a BI project remained poorly understood (Audzeyeva & Hudson, 2016; El-Adaileh & Foster, 2019; Hung et al., 2016; Olszak & Ziemba, 2012; Pham et al., 2016; Yeoh & Popovic, 2016). Very often, researchers have tended to focus on just one particular CSF or one particular aspect of the BI project implementation. Thus, little research has been recorded that encompasses all significant considerations with regard to CSFs of BI project implementation (El-Adaileh & Foster, 2019).

One reason for the failure of a BI project is the lack of understanding of the CSFs behind the successful implementation of the BI project (Hung et al., 2016). The CFSs should be embedded in the BI project implementation methodologies. Identifying CSFs in BI project implementation can help the project team to concentrate its efforts on solving prior issues and needed resources. Thus, ignoring it will be a major obstacle to success (Yeoh, Koronios, & Gao, 2008), and finding BI project implementation CSFs has become an urgent task for researchers seeking to fill the knowledge gap in this field of study (Hung et al., 2016).

To bridge this gap, this research identifies the CSFs of BI project implementation through content analysis of the existing BI project implementation methodologies. Then, some well-known BI project implementation methodologies will be compared based on the identified CSFs. In short, this research intends to answer the following questions:

1) What are the existing methodologies for implementing BI projects?
2) What are the CSFs of implementing BI projects from the perspective of BI project implementation methodologies?

3) What are the differences among the existing BI project implementation methodologies in terms of CSFs?

The remaining content of the paper is organized as follows. First, the theoretical foundations of the research, research background, and the existing BI project implementation methodologies are reviewed. Then, the research methodology is described, including analyses of data using the content analysis method. Validation of research findings using quantitative methods is presented, along with a comparison of BI project implementation methodologies based on the validated CSFs. Finally, it discusses the research findings and concludes with suggestions for future research.

LITERATURE REVIEW

BUSINESS INTELLIGENCE PROJECTS AND THEIR SUCCESS FACTORS

In 1958, IBM's researcher Hans Peter Luhn (1958) used the term "business intelligence" in his article. He defined BI as "the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal" (Luhn, 1985, p. 314; see also Azita, 2011; Mashudi et al., 2016). But what we know today as BI originated from decision support systems (Olszak, 2014) and evolved since 1960 until the mid-1980s. Dresner (1989), as stated in Rouhani, Asgari, and Mirhosseini (2012), defined BI as concepts and methods for improving business decision-making by using fact-based support systems. The detailed analysis of the literature shows that there is no universal definition for BI (Gangadharan & Swami, 2004; Nedelcu, 2013; Olszak & Ziemba., 2012; Power, 2007; Wixom & Watson 2010). Hence, many definitions of BI focus on the capability of an enterprise to improve business efficiency and achieve higher business goals (Inmon et al., 2008; Olszak & Ziemba, 2012). BI is a methodological transformation of data from various data sources into information for result-oriented decision-making (Olszak & Ziemba, 2007; Ranjan, 2009). The main capabilities of BI include information extraction, warehousing, and analysis of data (Lukić et al., 2016). In general, BI project implementation is the process of defining, designing, developing, and deploying a BI software application. Various researchers and consultants have defined different steps for BI project implementation (see Table 1).

The identification of CSFs is a popular method used by many authors (e.g. Eybers, 2015; Olszak & Ziemba, 2012; Pham et al., 2016; Yeoh, Gao, & Koronios, 2008; Yeoh & Koronios, 2010; Yeoh & Popovič, 2016) to investigate a particular item vital for an organization or project to achieve its mission. Therefore, the achievement of the item will be critical to the success of the organization or project. Olszak and Ziemba (2012, p. 136) refer to CSFs as a "set of tasks and procedures that should be addressed in order to ensure BI systems accomplishment". Thus, these items should be presented to ensure a successful BI project implementation. CSFs are subject specific, and consequently each type of project, industry, or context will dictate specific CSFs.

There are some specific criteria to assess the implementation success of a BI-related technology in the existing literature. Nevertheless, it appears that there are no commonly agreed success criteria for implementing a BI project (Hawking & Sellitto, 2010; Olszak & Ziemba, 2012; Pham et al., 2016; Yeoh & Koronios, 2010). Watson and Haley (1998) surveyed 111 organizations utilizing data warehouse solutions and found that success factors included management support, adequate resources, change management, and metadata management. Yeoh and Koronios (2010) classified CSFs of BI project implementation into three dimensions: organization, process, and technology. The organization dimension contains "committed management support and sponsorship" and "clear vision and well-established business case". The process dimension includes "business-centric championship and balanced team composition", "business-driven and an iterative development approach", and "user-oriented change management". The last dimension, technology, focuses on "business-driven, scalable and flexible technical framework" and "sustainable data quality and integrity". Pham et al. (2016) reviewed Yeoh and Koronios' (2010) framework of CSFs found in four Vietnamese companies. They verified all of the CSFs and also found four new important factors, including involvement of top

management, change management, performance considerations, and business-led data governance. They classified CSFs for BI in these three dimensions: environment, organization, and planning of the project (Pham et al., 2016). Villamarín-Garcia and Pinzón's (2017) research found 13 factors that contribute to improving the success rate of BI project implementation. These factors are: directives and top management, business linking, project leader or "champion" set up, business strategy, change management, 6BI project deployment, people and human talent team, learning and skills, information and technologies, professional networks, resource, metrics, and environment. Hirsimäki (2017) categorized CSFs of BI in three dimensions: organizational, process and technological CSFs. The organizational CSFs include clear vision and well-established business case; committed management support and sponsorship; and understanding of organizational culture. Process-related CSFs are appropriate team skills, user-oriented change management, and user training and support. The technological dimension includes business-driven, scalable and flexible framework; sustainable data quality, accuracy and integrity; and understanding the firm's needs, requirements and processes. Nguyen et al. (2018) referred to the following elements as the CSFs of BI: well-defined information and system requirements; BI function factors; clear link with business objectives; ongoing top management support and sponsorship; integration of BI and other systems; data quality and integrity; BI characteristics factors; and appropriate technology and tools. El-Adaileh and Foster (2019) found that vision, IT infrastructure, data sources systems, and IT infrastructure are the BI CSFs. Arizmendi and Stapleton (2019) declared that these elements are obstacles to success in BI project implementation: lack of user involvement; incorrect management of change; incorrect top management support; poor or incorrect requirements definition; unrealistic expectations; incorrect ISD (information system development) methodology; lack of project managerial and technical expertise; incorrect estimation of time and cost; inappropriate software choice; and stakeholder and organizational changes.

Business Intelligence Project Implementation Methodologies

BI project implementation is considerably more complex than other conventional IT projects due to factors such as expanded business framework, heterogeneous nature of data sources, and complexity of the requirements phase for each of the business segments, as well as cultural and organizational issues (Devarapalli, 2013; Lukic et al., 2016).

Data warehouse is a key technology of BI that integrates data from different sources for analytical purposes (Arnott, 2008; Inmon et al., 2008; Nasiri et al., 2017). It integrates data from disparate, heterogeneous, organization-wide systems and often represents them in a multidimensional model (Nasiri et al., 2017).

Many companies and researchers use DW and BI implementation methodologies in combination instead of one or the other. Each of these methodologies has its own characteristics, strengths and weaknesses (Despa, 2014; Yasser & Zota; 2016). However, a universal methodology for BI project implementation does not exist. The high percentage of failed BI projects indicates the need for a well-defined approach (List et al., 2002; Sen & Sinha 2005; Stefanovic & Stefanovic, 2011).

DW/BI implementations have been historically classified in one of two categories: Kimball's (Kimball et al., 1998) or Inmon's approach (Inmon et al., 2008). Bill Inmon, who is considered the "father of data warehousing," advocates for a top-down development approach that adapts traditional relational database tools to the development needs of an enterprise-wide DW. Ralph Kimball proposes the alternative of bottoms-up approach that involves building data marts, one at a time. In software engineering parlance, Inmon's approach can be viewed as waterfall-like and Kimball's as agile/iterative-like (Mueller, 2013). The general approaches to information system development are based on the traditional models of the waterfall life cycle (Royce, 1970) or the various types of dominant agile methodologies.

Sen and Sinha (2005) analyzed 15 different data-warehousing methodologies, which are fairly representative of the range of available approaches. In this current research, the BI/DW project methodologies developed from 1998 to 2019 were examined. Consequently, 23 common BI and DW implementation methodologies were identified: Pragmatic; element61; Theta; NewIntelligence; DataSkills; Edgematics; NEOS; TriCore BI; Primary prototyping of Yasser and Zota; OBIEE; EOK; MicroStrategy; GRT; POlAR; Kimball; BIM; ProServeIT; SQL Power; Arinze and Amobi; NOVA rapid prototype; Olszak and Ziemba BI implementation approach; Bara et al.'s development cycle; and Lukić et al.'s collaborative methodology. Out of the stated methodologies, 13 methodologies with more detailed information about their implementation stages were selected for comparative comparisons including: NewIntelligence; MicroStrategy; GRT; POlAR; Kimball; BIM; ProServeIT; SQL Power; Arinze and Amobi; NOVA Rapid Prototype; Olszak and Ziemba BI implementation approach; Bara et al.'s development cycle, and Lukić et al.'s collaborative methodology. The implementation steps of these methodologies are presented in Table 1, and they usually include planning, designing, developing, testing, setup, and maintaining a software product. Depending on the project type, some stages gain additional attention. The common set of tasks proposed in various DW methodologies includes business requirements analysis, data design, architecture design, implementation, and deployment (Kimball et al., 1998; Sen & Sinha, 2005).

Table 1. BI project implementation methodologies

Methodology name	Implementation steps	Reference
GRT	1. Strategy, 2. Definition, 3. Analysis, 4. Design, 5. Build, 6. Transition to Production, 7. Discovery	GRT, n.d.
MicroStrategy	1. Plan/Design, 2. Development, 3. Deployment, 4. Maintenance	MicroStrategy, n.d.
POLAR	1. Visualize, 2. Planning and architecture, 3. Develop and implement, 4. Deployment, 5. Maintain	POLAR, n.d.
Kimball et al.	1. Project planning, 2. Project management, 3. Business requirements definition (technology path, Data path, BI-path), 4. Deployment, 5. Maintenance, 6. Growth	Kimball et al., 1998 2008
Arinze & Amobi	1. Planning, 2. High-level requirements, 3. Software procurement, 4. Software Configuration, 5. Software testing, 6. Data extraction, 7. System deployment, 8. System Maintenance.	Arinze & Amobi, 2004
BI Minds or BIM	1. Plan, 2. Discover, 3. Configure, 4. Validate, 5. Customize (Design), 6. Deploy	BIM, n.d.
ProServeIT BI	1. Environment selection, 2. System architecture, 3. Data architecture (construction of BI* building blocks), 4. Pilot project development (A: pre check-in, B: business needs, C: data needs, D: tech needs, E: sprints, F: post QR) 5. Production (A: migration plan, B: rollback plan), 6. On-Going test	ProServeIT, 2016
SQL Power	1. BI Vision, 2. Scope, 3. Architecture, 4. Build, 5. Test, 6. Deploy, 7. Support, 8. Project management	SQL Power, n.d.
Novasys BI	1. Assessment, 2. Architecture, 3. Design/Development 4. Integration, 5. Deployment, 6. Support	NOVA, n.d.
Olszak & Ziemba	1. Creation of BI system A. determination of the BI system development strategies B. identification and preparation of source data C. selection of BI tools	Olszak & Ziemba, 2007

Methodology name	Implementation steps	Reference
	D. designing and implementing of BI E. discovering and exploring new informational needs and other business applications and practices 2. Use of BI system A. logistic analyses that enable to identify partners of supply chain quickly B. access, monitoring and analyses of facts C. development of alternative decisions D. division and co-operation E. change in the effect of company performance	
Bara et al.	1. Business justification (Step 1 Business Case Assessment) 2. Planning (Step 2 Enterprise infrastructure evaluation and Step 3 Project planning) 3. Business analysis (Step 4 Defining business needs, Step 5 Data analysis, Step 6. Application prototyping, and Step 7 Metadata analysis) 4. System design (Step 8 Data design, Step 9 Designing the ETL* process, and Step 10 Design metadata repository) 5. Development (Step 11 ETL development, Step 12 Application development, Step 13 Data mining, and Step 14 Developing metadata repository) 6. System implementation (Step 15 Implementation, and Step 16 System testing)	Bara et al., 2009
Lukić et al.	P1. Planning and project preparation A: Strategic analysis, B: Selection of organizational units P2. Business requirements A: Designing and choosing indicators, B: Action plan for achieving the goals P3. Dimensional modeling A: Focusing on the informational structure, B: ERM* in the informational sense involves, C: Focusing on the analytical capabilities, D: MDM* for a business process involves P4. Physical design A: MDM for BW* P5. Data integration A: Design and implementation of an ETL system P6. Product selection and installation A: Setting up hardware infrastructure, B: Setting up software infrastructure P7. Report design and analytics A: Designing a BI application for reporting P8. Report and analytics development A: Designing a BI application for reporting P9. Final preparation A: Start of production P10. Go live and support	Lukić et al., 2016

Methodology name	Implementation steps	Reference
NewIntelligence	1. Business requirements, 2. Data warehouse design, 3. Data warehouse build, 4. BI architecture and modeling, 5. Project planning, 6. Post-Implementation, 7. In closing	Mandel, 2017

* BI: Business Intelligence, ETL: Extract, Transform and Load (data); ERM: entity relationship model; MDM: multidimensional model; BW: Business Warehouse

RESEARCH METHOD

This is an applied research with a qualitative-quantitative approach. The research methodology of this paper is composed of 4 steps (Table 2).

Table 2. Research steps

Research Steps	Phases (sub-steps)	Aim
Step 1: Literature review	Studying library resources, articles, theses, and books	To define research questions and research goal. To find the existing BI* project implementation methodologies
Step 2: Thematic analysis	1) Familiarizing yourself with data, 2) Generating initial codes (open coding), 3) Searching for themes, 4) Reviewing themes, 5) Defining and naming themes, and 6) Producing the report.	To identify CSFs* for BI Project implementation based on BI project implementation methodologies
Step 3: Validation of identified CSFs	1) Developing and distributing questionnaire 1 among experts, 2) Analyzing gathered data using CVR* to validate the identified CSFs, 3) Developing and distributing questionnaire 2 among experts, 4) Analyzing gathered data using Fuzzy Delphi method to validate the identified CSFs	To validate the identified CSFs for BI project implementation
Step 4: Comparison of existing BI methodologies	Comparing existing BI methodologies based on the validated CSFs	To find the completeness of studied BI project implementation methodologies

* BI: Business Intelligence, CSF: Critical Success Factor, CVR: Content Validity Ratio

In the *first step*, relevant journal articles, theses, and books were scanned to collect information. Different methodologies to BI project implementation were found in this step. The keywords included *business intelligence; business intelligence implementation; business intelligence methodology; business intelligence implementation approach and business intelligence implementation method*. The used scientific databases included Emerald Insight, Springer, Science Direct, IEEE, as well as searching in google search engine.

In the *second step*, the content of BI project implementation methodologies was analyzed using the thematic analysis technique. Thematic analysis, a qualitative analytic method, provides the essential structure required for many qualitative analysis (Holloway & Todres, 2003). We followed the "six phases" guideline proposed by Braun and Clarke (2006) to conduct thematic analysis. Specifically, the thematic analysis was conducted according to the following steps:

- Familiarize with data, complete the "open coding" phase to generate initial codes (conceptual labels), search for themes, review themes, define themes, name themes, and produce report (phase 1-6 of thematic analysis as described above). One researcher studied the details of the

13 BI methodologies first to prepare for the coding. During the opening coding process, the key concepts of the BI project implementation methodologies were identified and labelled, and open codes were registered as "researcher's notes". Then, the researcher's notes were reviewed to shape "themes". Lastly, the themes were reviewed again and named to be considered as CSFs for BI project implementation.

- Match the open codes with the researcher's notes. This step was done by the other researcher, checking the assigned notes for approval and correcting if necessary, in consultation with the first researcher.
- Match the researcher's note with the themes/CSFs. This was also done by the other co-researcher, verifying the identified themes and correcting if necessary, again in consultation with the first researcher.

Therefore, the reliability of all open coding and related themes was ensured through alternated double checking in several rounds.

In the *third step*, two questionnaires were used to validate the identified CSFs through quantitative methods. The two questionnaires consisted of the same set of questions, but used different scales. The first questionnaire used a 3-point scale, including "essential," "useful, but not essential," and "not essential". The second questionnaire used a 9-point scale ranging from (1) "very unimportant" to (9) "very important" (see Appendix for specifics). To ensure validity of the questionnaires, the questions were reviewed by two BI experts, and necessary corrections were made to ensure that the questionnaires measured what they were meant to measure.

Then, the questionnaires were distributed online to participants via email and Telegram, which is a cloud-based instant messaging and voice over IP service. Telegram client apps are available for Android, iOS, Windows Phone, Windows NT, macOS and Linux. Users can send messages and exchange photos, videos, stickers, audio and files of any type. The survey participants were not randomly sampled, but rather purposefully selected from reachable BI professionals. They included IT managers, university professors of IT and industrial engineering, and specialists working in BI project implementer companies. The selection criteria were that the person should have four or more years of working experience in BI and also have a PhD or MSc degree (Table 3). They were BI experts and were independent because they had experiences in different BI projects and had not any noticeable preference of a specific BI project implementation methodology or product.

Table 3. Education and work experience of the experts

Experts in the first stage (25 person)			
Education	Per cent	Work experience	Per cent
PhD	40.0	Between 4 and 6 years	80.0
Master	60.0	Between 7 and 9 years	12.0
		More than 10 years	8.0
Experts in the second stage (15 person)			
Education	Per cent	Work experience	Per cent
PhD	53.3	Between 4 and 6 years	73.3
Master	46.7	Between 7 and 9 years	20.0
		More than 10 years	6.7

With the first questionnaire, a survey of 25 experts was conducted to validate the CSFs through CVR approach. Lawshe's method for calculating CVR was initially proposed in a seminal paper in 1975. It involves a panel of subject matter "experts" rating items into one of the three categories: "essential," "useful, but not essential", or "not essential". According to Ayre and Scally (2014), items deemed "essential" by a critical number of panel members are then included within the final instrument, with items failing to achieve this critical level discarded. Calculation of CVR was done based on the following formula.

$$CVR = \frac{n_e - {}^{N}/_{2}}{{}^{N}/_{2}}$$

Where **N** is the total number of experts and $\mathbf{n_e}$ is the number of experts who have chosen the essential option. The gathered data analyzed using Excel software. Also, Cronbach's alpha was calculated to assess the reliability of the questionnaire. The alpha coefficient was 0.725, greater than 0.7, indicating that its reliability was acceptable.

The second questionnaire was distributed to 15 out of those 25 participants, who were willing to continue, in order to screen CSFs through the Fuzzy Delphi method, a qualitative forecasting model introduced by Kaufman and Gupta in 1988. Usually, the evaluation involves uncertain and imprecise datasets, where the experts' opinions are often subjective and based solely on their competency (Tarmudi et al., 2016). Although experts use their competencies and mental abilities to make comparisons, it should be noted that the traditional process of quantifying people's views does not fully reflect the style of human thinking. In other words, the use of fuzzy sets is more compatible with linguistic and sometimes vague human descriptions, and it is therefore best to use a fuzzy set (fuzzy numbers) for long-term prediction and real-world decision making (Cheng et al., 2009). In this study, triangular fuzzy numbers were used to fuzzy the experts' views, as shown in Table 4 and Figure 1.

Table 4. 9-point fuzzy spectrum for the valuation of indices

Crisp equivalent	Linguistic variable	Fuzzy number scale
1	very unimportant	**(1,1,1)**
2	very unimportant to unimportant	**(1,2,3)**
3	unimportant	**(2,3,4)**
4	unimportant to medium	**(3,4,5)**
5	medium	**(4,5,6)**
6	medium to important	**(5,6,7)**
7	important	**(6,7,8)**
8	important to very important	**(7,8,9)**
9	**very important**	**(8,9,9)**

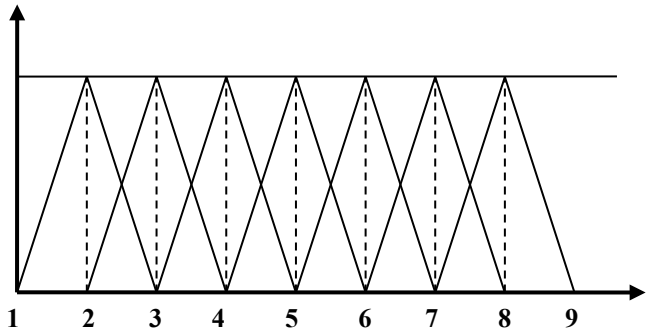

Figure 1. Valuation of indices relative to each other using triangular fuzzy numbers

In the next step, the experts' opinions should be aggregated. Various methods have been proposed to aggregate the opinions of **N** responders. For example, a conventional method for aggregating a set of triangular fuzzy numbers with a minimum **l** and a geometric mean **m** and max **u** are considered as follows:

(1) $F_{AGR} = (\min\{1\}.\prod\{m\}.\max\{u\})$

In this research, each triangular fuzzy number was derived from the aggregation of the opinions (τ_j) of the experts for the j index, as follows:

$\tau_j = (L_j.M_j.U_j)$

$L_j = \min(X_{ij})$

$M_j = \sqrt[n]{\prod_{i=1}^{n} X_{ij}}$

$U_j = \max(X_{ij})$

Indicator (**i)** refers to the expert.

- Where X_{ij} is the value of the j's measure that evaluated by the expert i's.
- Where L_j is the minimum valuation for the measure j's.
- Where M_j is the geometric mean of the experts' evaluations of the measure j's performance.
- Where U_j is the maximum in valuation for the measure j's (Cheng et al., 2009; Wu & Fang, 2011).

The triangular fuzzy numbers can be mapped to a crisp number. This is called "defuzzification". In this study, the center of area method (COA) was used for defuzzification as following:

- (2) $DF_{ij} = \frac{[(u_{ij}-l_{ij})+(m_{ij}-l_{ij})]}{3} + l_{ij}$ (Tzeng & Teng, 1993)

It is notable that calculation of the Fuzzy Delphi method was done using MATLAB software.

Finally, in the *fourth step*, the existing BI project implementation methodologies were compared based on the validated CSFs derived from CVR and Fuzzy Delphi methods.

RESULTS

In the first step of the research (literature scan), information about the existing BI project implementation methodologies was gathered. The abstract findings of this step were displayed in Table 1. Now, the findings of the other research steps (steps 2-4 according to Table 2) are presented in the following sections.

CSFs IDENTIFIED WITH THEMATIC ANALYSIS

Recall that the texts of existing BI project implementation methodologies were analyzed in terms of the 13 project implementation methodologies (selected from the 23 identified from the literature), to produce "open codes" and subsequently themes. These texts included the details of each BI project implementation methodology and its steps. The researcher read each sentence of the text to create open codes, extracted important keys from open codes, and recorded them in/as research notes, as illustrated with examples in Table 5. The translation of BI project implementation methodologies was double checked by the second co-researcher. Then, the researcher notes were reviewed (phase 3) and categorized to form the themes (phase 4). Finally, themes were defined, named (phase 5), and compiled, as illustrated in Table 6, which shows a sample of categorized researcher notes and extracted themes to identify CSFs for BI project implementation.

Table 5. Examples of open coding

Reference	Methodology steps	Open coding	Researcher notes
NEOS, 2013	Implementation	Implementing security policies (horizontal and vertical access policies), system final testing, and system optimization are the key factors in BI systems deployment.	-Implementing security policies (horizontal and vertical access policies) -System final testing -System optimization
NEOS, 2013	Logical architecture	Architecture refers to setting the project framework in terms of the logical architecture of the system and the stage of the program development.	BI system architecture
NEOS, 2013	Training	Training is held in the form of interactive workshops with end-users whereby solving specific problems, system is introduced to future users.	Training and supporting users and managers
EOK, n.d.	Strategy	During this phase, project strategic vision is created	Creating project strategic vision

Table 6. An example of defining and naming themes

Reference	Researcher notes	Themes/CSFs*	Number of repetitions
GRT, n.d.	Defining BI* project goals	BI strategy and vision	
POlAR, n.d.	Creating information strategy roadmap		
SQL Power, n.d.	BI strategic planning		
Olszak & Ziemba, 2007	Determining BI development strategy		
Lukić et al., 2016	Defining BI project goals		
Microstrategy, n.d.	Support and recovery strategy		
Microstrategy, n.d.	Project planning	Project management	9
Kimball et al., 2008	Project planning		
SQL Power, n.d.	Creating project group		
BIM, n.d.	Determining the BI project efficiency		
Arinze & Amobi, 2004	Project planning		
ProServeIT, 2016	BI project performance assessment		

Ultimately, 20 CSFs were identified: (1) "Obvious BI strategy and vision", (2) "Project management", (3) "Business requirements definition", (4) "Business readiness assessment", (5) "BI performance assessment", (6) "Change management", (7) "Establishing BI alignment with business goals", (8) "Developing and sharing deployment plan", (9) "Training users and managers", (10) "Planning and architecture", (11) "Management support", (12) "Organizational cooperation in BI implementation", (13) "IT support for BI", (14) "Creating comprehensive communication plan", (15) "Creating data resources and quality of source data", 16. "Creating the BI program prototype", 17. "BI program repetitive development", 18. "Installing and integrating the BI program", 19. "BI system testing", 20. "BI system support and maintenance".

VALIDATION OF THE IDENTIFIED CSFS

After thematic analysis and extracting the main themes as CSFs of BI project implementation, experts' opinions about each CSF were gathered with two questionnaires in order to validate the CSFs. Then quantitative analysis was performed on the collected data, and the validity of CSFs were evaluated using CVR index and the fuzzy Delphi method.

Content validity ratio

Drawing on the survey responses from 25 BI experts, Content Validity Ratio (CVR) was calculated for each of the 20 CSFs identified in the previous stage. The results are listed in Table 7. Given the number of experts who completed the survey (25), the minimum CVR must be 0.37 for an item to be acceptable. Items with a CVR value less than the desired level should be eliminated because they don't have acceptable content validity. As shown in Table 7, CSFs #1,3,4,5,7,11,13,15,18,19, and 20 have a CVR value greater than the critical value and are accepted.

Table 7. Calculation of CVR for identified CSFs

CSFs of BI project implementation	Index	n	CVR	"Essential"	"Useful but not essential"	"Not essential"	Decision
Obvious BI strategy and vision	C01	*22*	*0.76*	*22*	*3*	*0*	Accept
Project management	C02	*17*	*0.36*	*17*	*7*	*1*	Reject
Business Requirements Definition	C03	*24*	*0.92*	*24*	*1*	*2*	Accept
Business readiness assessment	C04	*18*	*0.44*	*18*	*7*	*2*	Accept
BI performance assessment	C05	*21*	*0.68*	*21*	*2*	*2*	Accept
Changes management	C06	*12*	*-0.04*	*12*	*12*	*1*	Reject
Establishing BI alignment with business goals	C07	*21*	*0.68*	*21*	*4*	*0*	Accept
Developing and sharing deployment plan	C08	*11*	*-0.12*	*11*	*1*	*6*	Reject
Training users and managers	C09	*16*	*0.28*	*16*	*9*	*0*	Reject
Planning and architecture	C10	*17*	*0.36*	*17*	*7*	*7*	Reject
Management support	C11	*23*	*0.84*	*23*	*2*	*0*	Accept
Organizational cooperation	C12	*15*	*0.20*	*15*	*10*	*0*	Reject

CSFs of BI project implementation	Index	n	CVR	"Essential"	"Useful but not essential"	"Not essential"	Decision
IT support for BI	C13	*18*	*0.44*	*18*	*7*	*0*	Accept
Creating comprehensive communication plan	C14	*6*	*-0.52*	*6*	*14*	*5*	Reject
Creating data resources and quality of source data	C15	*20*	*0.60*	*20*	*5*	*0*	Accept
Creating the BI program prototype	C16	*8*	*-0.36*	*8*	*11*	*6*	Reject
BI program repetitive development	C17	*12*	*-0.04*	*12*	*9*	*4*	Reject
Installing and integrating the BI program	C18	*20*	*0.60*	*20*	*5*	*0*	Accept
BI system testing	C19	*19*	*0.52*	*19*	*5*	*1*	Accept
BI system support and maintenance	C20	*20*	*0.60*	*20*	*3*	*0*	Accept

Fuzzy delphi method

In this sub-step, a 9-points scale questionnaire was distributed to willing participants, and 15 responses were collected from BI experts about the importance of each CSFs, with each response being a 9-points fuzzy spectrum (as shown in Table 4, second column). The fuzzy Delphi method was used to screen CSFs by aggregating experts' opinions (as explained in the "Research Method" section).

For defuzzification, usually the mean of the triangular and trapezoidal fuzzy numbers can be summarized by a crisp value, which is the best average. The fuzzy averages and defuzzification values related to the CSFs are shown in Table 8. Defuzzification values greater than 7 are acceptable, and those CSFs with a rating greater than 7 should be accepted (Wu & Fang., 2011).

As a result, 11 CSFs had a defuzzification value greater than 7 and thus accepted, and 9 CSFs had a defuzzification value less than 7 and thus rejected.

Table 8. Fuzzy Delphi method calculations (first round)

	Min	Geo_mean	Max	Mean	Crisp	Result
C01	6	8.42	9	(6, 8.42, 9)	7.81	Accept
C02	4	7.96	9	(4, 7.96, 9)	6.99	Reject
C03	6	8	9	(6, 8, 9)	7.67	Accept
C04	6	7.62	9	(6, 7.62, 9)	7.54	Accept
C05	6	8.56	9	(6, 8.56, 9)	7.85	Accept
C06	4	7.57	9	(4, 7.57, 9)	6.86	Reject
C07	6	7.88	9	(6, 7.88, 9)	7.63	Accept
C08	4	7.44	9	(4, 7.44, 9)	6.81	Reject
C09	4	7.74	9	(4, 7.74, 9)	6.91	Reject
C10	4	7.48	9	(4, 7.48, 9)	6.83	Reject
C11	5	8.13	9	(5, 8.13, 9)	7.38	Accept
C12	4	7.28	9	(4, 7.28, 9)	6.76	Reject
C13	6	8.85	9	(6, 8.85, 9)	7.95	Accept
C14	4	7.78	9	(4, 7.78, 9)	6.93	Reject

	Min	Geo_mean	Max	Mean	Crisp	Result
C15	5	7.36	9	(5, 7.36, 9)	7.12	Accept
C16	4	7.48	9	(4, 7.48, 9)	6.83	Reject
C17	3	6.38	8	(3, 6.38, 8)	5.79	Reject
C18	6	7.94	9	(6, 7.94, 9)	7.65	Accept
C19	5	7.67	9	(5, 7.67, 9)	7.22	Accept
C20	6	8.01	9	(6, 8.01, 9)	7.67	Accept

In the second round, the significance of the 11 remaining CSFs was measured again. The results of screening the remaining CSFs are presented in Table 9. The defuzzification values of all remaining CSFs are greater than 7, and thus no further reduction.

Table 9. Fuzzy Delphi method calculations (second round)

	Min	Geo_mean	max	mean	Crisp	Result
C01	6	8.04	9	(6, 8.04, 9)	7.68	Accept
C03	5	7.6	9	(5, 7.6, 9)	7.20	
C04	5	7.44	9	(5, 7.44, 9)	7.15	
C05	6	8.1	9	(6, 8.1, 9)	7.70	
C07	5	8.09	9	(5, 8.09, 9)	7.36	
C11	5	8.04	9	(5, 8.04, 9)	7.35	
C13	5	7.59	9	(5, 7.59, 9)	7.20	
C15	5	7.68	9	(5, 7.68, 9)	7.23	
C18	5	7.62	9	(5, 7.62, 9)	7.21	
C19	6	8.04	9	(6, 8.04, 9)	7.68	
C20	5	7.91	9	(5, 7.91, 9)	7.30	

COMPARISON OF EXISTING METHODOLOGIES

In the *fourth* step, a comparative matrix (Table 10) was used to compare the existing BI methodologies based on the 11 identified CSFs. The comparison matrix determines which of the methodologies has considered the identified CSFs for BI implementation project. It means that for each methodology, we checked if the methodology had an open code leading to the one CSF or not. If yes, it was marked by inserting an asterisk in the cell at intersection of the row and column corresponding to the BI methodology and the specific CSF in the matrix. As shown in Table 10, among the identified CSFs, three CSFs ("Business requirements definition"; "Creating data resources and quality of source data"; and "BI system support and maintenance") have been considered in all BI project implementation methodologies. Also, the CSFs "IT support for BI" and "Management support" have been considered only in about half of the studied BI project implementation methodologies.

Table 10. BI project implementation methodologies comparison matrix

CSFs for BI implementation / BI implementation methodologies	Obvious BI strategy and vision	Business requirements identification	BI performance assessment	Business readiness assessment	Establishing BI alignment with business goals	Management support	Installing and integrating the BI program	Creating data resources and quality of source data	BI system testing	BI system support and maintenance	IT support for BI
GRT, n.d.	*	*	*	*	*	*	*	*	*	*	*
POlAR, n.d.	*	*	*	*	*	*	*	*	*	*	*
SQL Power, n.d.	*	*	*	*	*	*	*	*	*	*	*
ProServeIT, 2016	*	*	-	*	*	*	*	*	*	*	*
MicroStrategy, n.d.	*	*	*	-	*	*	*	*	*	*	-
Kimball et al., 2008	*	*	*	*	*	-	*	*	*	*	*
BIM, n.d.	*	*	-	*	*	-	*	*	*	*	-
NOVA, n.d.	*	*	*	*	*	-	*	*	*	*	-
Olszak & Ziemba, 2007	*	*	*	-	*	*	*	*	-	*	*
Bara et al., 2009	-	*	*	*	-	-	*	*	*	*	-
Lukić et al., 2016	*	*	*	*	*	*	-	*	*	*	*
Arinze & Amobi, 2004	-	*	*	*	-	*	*	*	*	*	-
Newintelligence, 2017	-	*	*	*	*	-	-	*	-	*	*

The similarities of the studied BI project implementation methodologies are:

- The core of BI projects is "Business requirements identification" and "Creating data resources and quality of source data". These two CSFs extract vital information to support organizational decision-makers. All the BI implementation methodologies emphasize these two CSFs.
- BI Implementation is a time consuming and complex operation. Therefore, it requires "BI system support and maintenance" after deployment. This CSF has been considered in all methodologies.

On the other hand, the differences in the studied BI project implementation methodologies are:

- Some of the methodologies do not pay much attention to "IT supports for BI".

- In the implementation of an integrated BI project, a long-term vision is needed first. All BI project implementation methodologies have taken this factor into account in their implementation, except for the methodologies presented by Arinze and Amobi, NewIntelligence, and Barra et al.
- "Management support" has been widely recognized as a CSF in BI project implementation. All methodologies emphasize this CSF, with the exception of NOVA, BIM, NewIntelligence, Kimball, and Bara et al.
- All methods other than Olszak and Ziemba's methodology emphasize "BI system testing" in BI project implementation.
- All methodologies, other than BIM and ProServeIT methodologies, take into account the "BI performance assessment" in BI project implementation.
- "Establishing BI alignment with business goals" is one of the CSFs in BI project implementation that all BI project implementation methodologies consider, with the exception of Barra et al. and Arinze & Amobi.
- All methodologies, with the exception of MicroStrategy and Olszak & Ziemba, emphasize the "business readiness assessment" in BI project implementation.

In the following, the specific features of each BI project implementation methodology are presented.

- GRT's methodology expresses "Obvious BI strategy and vision" as one of the CSFs in BI implementation, and considers this as a major phase in its own methodology. The other CSFs have been considered as the subset of the phases.
- The MicroStrategy methodology focuses more on "BI system support and maintenance" and "Business requirements identification", and considers them as the key steps in implementing BI project. This methodology does not pay attention to "Business readiness assessment" and "IT Support for BI Implementation".
- The Kimball methodology considers all the CSFs for BI project implementation, but it does not pay attention to the "Management support" factor. Also, it considers "Business requirements identification", and "BI system support and maintenance" as the main phases of the BI project implementation.
- The BIM methodology does not pay much attention to the "BI performance assessment", "IT support form BI", as well as "Management support".
- The ProServeIT methodology considers all CSFs other than the "BI system performance assessment", and focuses on "BI system test".
- The SQL Power methodology emphasizes all CSFs, and focuses on "Obvious BI strategy and vision", "BI system test", and "BI system support and maintenance". These three CSFs are introduced as major steps this methodology.
- The NOVA methodology focuses on "Management support for BI implementation". In this methodology, "Installing and integrating the BI program" and "BI system support and maintenance" have been considered as the key steps in BI project implementation.
- Olszak and Ziemba do not consider "Business readiness assessment" and "BI system test" as CSF for BI project implementation in their methodology. They focus more on developing an "Obvious BI strategy and vision" and "Creating data resources and quality of source data". These CSFs have been considered as the key steps in their BI project implementation methodology.
- Lukić et al.'s methodology considers all CSFs other than the "installation and integration of BI program".
- Arinze and Amobi do not consider CSFs such as creating an "Obvious BI strategy and vision", "Establishing BI alignment with business goals", and "IT supports from BI". Their methodology emphasizes the "BI system testing", "BI system support and maintenance",

and "Creating data resources and quality of source data". It has raised these CSFs as major phases of the BI project implementation methodology.

- NewIntelligence methodology does not consider CSFs such as creating an "Obvious BI strategy and vision", "BI system testing", "Installing and integrating the BI program", "Management support", and "IT supports from BI". This methodology emphasizes other CSFs and considers "Business requirements identification" as the key step.

FINDINGS

According to the results of analysis, the 13 BI project implementation methodologies can be categorized into four groups based on the number of CSFs that they have considered for BI project implementation. The four groups are presented in Table 11.

Table 11. Grouping studied BI project implementation methodologies

Group number	Methodology	CSFs that were not considered in BI project implementation methodology
Group 1	**GRT, n.d.**	0
	SQL Power, n.d.	0
	POlAR , n.d.	0
Group 2	**Lukić et al., 2016**	Installing and integrating BI programs
	ProServeIT, 2016	BI performance assessment
	Kimball et al., 2008	Management support
Group 3	**MicroStrategy, n.d.**	Business readiness assessment - IT support for BI
	NOVA, n.d.	Management support - IT support for BI
	Olszak & Ziemba, 2007	Business readiness assessment - BI system test
Group 4	**BIM, n.d.**	BI performance assessment - IT support for BI - Management support.
	Arinze & Amobi, 2004	Obvious BI strategy and vision - Establishing BI alignment with business goal - IT support for BI
	NewIntelligence, 2017	Obvious BI strategy and vision - BI system testing - Installing and integrating the BI program - Management support
	Bara et al., 2009	Obvious BI strategy and vision - Establishing BI alignment with business goal - IT support for BI - Management support

The first group of methodologies consider all the 11 CSFs for BI project implementation. These are more complete than the methodologies of the other groups. Therefore, organizations that intend to implement BI project, as well as companies that provide BI solutions, can use these methodologies for their own purposes. Those in the second group failed to recognize one of the 11 CSFs in their methodologies but emphasize the 10 other CSFs. Those in the third group did not consider two of the 11 CSFs for BI project implementation but emphasizes the 9 other CSFs. Finally, those in the fourth group did not recognize 3 or more out of the 11 CSFs. This group paid least attention to the identified CSFs in the implementation of BI project.

DISCUSSION

As recognized in previous studies (Olszak & Ziemba, 2012; Saavedra & Bach, 2017; Yeoh et al., 2008; Yeoh & Koronios, 2010; Yeoh & Popovič, 2016), identifying CSFs for implementing BI project is an appropriate and efficient way to understand BI project implementation. Different industries may have different business needs regarding BI project implementation. However, the list of CSFs for BI project implementation is somewhat general. There is no consensus on what factors to consider for the success of BI project implementation (El-Adaileh & Foster, 2019).

Some authors who have identified CFSs of BI implementation and proposed different classifications of CFSs. Some of these authors have integrated several factors into one factor, and others have considered each CSF as a separate factor. For example, Villamarín-Garcia and Pinzón (2017) considered "Directives top management" as a separate factor, but placed "Well defined business requirements related to information", "Identify key performance indicators (KPI)", and "Involve business affairs with the technical factors" under "Business linking" as subordinate factors. Hirsimäki (2017) considered "Suitability of technologies and infrastructure", "Sustainable data quality, accuracy and integrity", "Understanding the firm's needs, requirements and processes", but as subcategories of the technological dimension. However, in the research by Nguyen et al. (2018), "Ongoing top management support and sponsorship", "Data quality and integrity", and "Well-defined information and system requirements" were considered as key factors. Qushem et al. (2017) and Eybers (2015) classified BI project implementation CSFs into three different dimensions: Organization, Environment, and Project planning, but Hirsimäki (2017) classified CSFs of BI project implementation into Organizational, Process and Technology dimensions.

The review of the literature on CSFs of BI shows that in lots of relevant articles, the CSFs have been identified based upon the analysis of previously published articles or through doing a case study. This paper distinctively seeks to identify a set of CFSs that have been considered jointly in *several BI project implementation methodologies* rather than *previous articles*. The majority of the identified CFSs in this study are consistent with the approved CFSs in previous relevant articles, but under other similar titles as stated in Table 12. For example, "Obvious BI strategy and vision" stated as "vision", "strategy", "Clear vision and well established business case", and so on (Row 1 of Table 12). Of the 11 identified CSFs, 10 have been confirmed in the literature. In this study, the CSF "*Expert assessment of business readiness for successful implementation of BI*" has been confirmed by experts in addition. Among the identified CSFs in this research, "Obvious BI strategy and vision"; "Business requirements definition"; "Establishing BI alignment with business goals"; "Management support"; "Creating data resources and quality of source data" are the most repeated CSFs for BI project implementation.

Some authors (El-Adaileh & Foster, 2019; Hirsimäki, 2017; Koronios & Yeoh, 2010; Nguyen et al., 2018; Yeoh & Popovič, 2016) stated that "Change management" is a CSF that has a direct and positive impact on the performance of BI systems. However, in our study although experts diagnosed the importance of this factor for BI project implementation, but they have not considered it as necessary for BI project implementation. There seems to be a variety of definitions for CSFs of BI project implementation and the concept of change management (El-Adaileh & Foster, 2019).

Table 12: Comparison of research findings with previous studies

	EI-Adaileh & Foster, 2019	Arizmendi & Stapleton, 2019	Nguyen et al., 2018	Villamarín-Garcia & Pinzón, 2017	Hirsimäki, 2017	Pham et al., 2016	Eybers, 2015	Olszak & Ziemba, 2012	Yeoh & Koronios, 2010	Yeoh et al., 2008
Obvious BI strategy and vision	Vision			Strategy	Clear vision and well established business case	A clear vision and a well-established business case	Strategy	Clear business vision and plan	Clear vision and well-established business case.	**Clear business vision and well-established case**
Business requirements definition		Improved requirements management using iterative, sense making processes and more user involvement	Well-defined information and system requirements	Business linking (defined business requirements related to information)	Understanding the firm's needs, requirements and processes		Business requirements			
BI performance assessment			BI function factors	Business linking (identify key performance indicators)		Technical framework	System performance (operational management)			
Establishing BI alignment with business goals			Clear link with business objectives	Business linking (involve business affairs with the technical)				Adjusting the BI solution to users' business expectation (requirements)	Business-driven, scalable and flexible technical framework	
Management support		Improved change management and political management (such as creating ownership and commitment)	Ongoing top management support and sponsorship	Directives and Top Management	Committed management support and sponsorship	Committed management support and sponsorship	Management backing	Support from senior management	Committed management support and sponsorship	**Committed management support and sponsorship**

	EI-Adaileh & Foster, 2019	Arizmendi & Stapleton, 2019	Nguyen et al., 2018	Villamarín-Garcia & Pinzón, 2017	Hirsimäki, 2017	Pham et al., 2016	Eybers, 2015	Olszak & Ziemba, 2012	Yeoh & Koronios, 2010	Yeoh et al., 2008
Installing and integrating BI programs	IT infrastructure		Integration of BI and other systems	Information and technology (Interaction with other systems)	Business-driven, scalable and flexible technical framework	Business-driven, scalable and flexible technical framework		Integration between BI system and other systems	Business-driven, scalable and flexible technical framework	
Creating data resources and quality of source data	Data sources systems		Data quality and integrity	Information and technology (sustainability quantity and quality of data- Source data systems)	Sustainable data quality, accuracy and integrity	Sustainable data quality and integrity	Quality	Data quality	Sustainable data quality and integrity	**Sustainable data quality and governance framework**
BI system testing				Information and technology (tests)						
BI system support and maintenance			BI characteristics factors	Information and technology (upgradability and flexibility-support of interactive systems)						**Strategic and extensible technical framework**
IT* support for BI	IT infrastructure		Appropriate technology and tools	Information and technologies				Appropriate technology and tools		**Infrastructure-related issues**

CONCLUSION AND SUGGESTION FOR FUTURE RESEARCH

This study aimed to reduce the risk of a fail in BI project implementation by finding CSFs for BI project implementation through "content analysis" of the existing BI implementation methodologies. Referring to the electronic resources, 23 common methodologies were identified for implementation of BI project and data warehouse. These 23 methodologies were found from articles on BI implementation, BI solutions vendor's websites, and websites of BI and data warehouse consultant companies. The methodologies include: Pragmatic, element61, Theta, NewIntelligence, DataSkills, Edgematics, NEOS, TriCore BI, Primary prototyping of Yasser and Zota, OBIEE, EOK, MicroStrategy, GRT, POlAR, Kimball, BIM, ProServeIT, SQL Power, Arinze and Amobi methodology, NOVA, Olszak and Ziemba's BI Implementation Approach, Bara et al.'s development cycle and Lukić et al.'s collaborative methodology. Among the mentioned methodologies, 13 methodologies which had more detailed information about their implementation stages were selected for comparative comparisons. They include NewIntelligence, MicroStrategy, GRT, POlAR, Kimball, BIM, ProServeIT, SQL Power, Arinze and Amobi's methodology, NOVA rapid prototype methodology, Olszak and Ziemba's BI Implementation Approach, Bara et al.'s development cycle and Lukić et al.'s collaborative methodology. Then, CSFs for BI project implementation were extracted by analyzing the content of these 13 methodologies. To validate the identified CSFs, CVR and Fuzzy Delphi methods were used. The results revealed 11 CSFs that should be considered in a BI project implementation, which were identified from representative BI project implementation methodologies and confirmed by field experts. These CFSs are: "Obvious BI strategy and vision", "Business requirements definition", "Business readiness assessment", "BI performance assessment", "Establishing BI alignment with business goals", "Management support", "IT support for BI", "Creating data resources and source data quality", "Installation and integration BI programs", "BI system testing", and "BI system support and maintenance". These CSFs represent the important aspects of BI project implementation methodologies and approaches. Also, GRT, Polar, and SQL Power methodologies were found to be more complete than other methodologies.

The BI methodological perspective of this paper is unique compared to the previous related research. This study contributes to the current theory and practice in the following ways. Frist, it identified a complete list of CSFs for BI projects implementation. Second, by comparing the existing BI project implementation methodologies based on the BI project CSFs, more complete it BI project implementation methodologies introduced. Finally, it found a new CSF, "*Expert assessment of business readiness for successful implementation of BI*", not present in the previous studies. The CSFs identified in this study can be used effectively by organizations that intend to implement BI project. The results of the research can help improving the way of BI project implementation in the organizations. So, it can be used to reduce the failure rate of BI project implementations. The results may be useful for managers, policy makers, business analysts and IT professionals to plan and implement BI project. Furthermore, the identified CSFs can give them a better understanding about the BI project implementation methodologies.

Our lack of free access to published information about all of the existing BI project implementation methodologies is a limitation of this research that may affect the completeness of found CSFs. Future researchers may add other BI project implementation methodologies and replicate this research. Also, they can divide CSFs into these three categories: required before BI project implementation, required during BI project implementation, and required after BI project implementation. This classification can provide more insight for organizations to get a successful implementation of BI project. Moreover, researchers can rank the CSFs of BI project implementation identified in this study. Furthermore, Critical Failure Factors (CFFs) need to be explored by studying cases of failed BI projects. CFFs can be used for improving existing BI project implementation methodologies or developing a new methodology that focuses on CSFs while avoiding CFFs simultaneously. The identified CSFs probably affect each other. So, studying the relationship between them can be a topic for future research as well.

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APPENDIX

Questionnaire 1

Personal Information:

Age:	Work Experience and Knowledge of BI (years):
Education level:	Field of Study:

Questions:
What do you think about the necessity of each factor sated below for the success of Business Intelligence System (BIS) implementation project?

factors	essential	useful, but not essential	not essential
1. Obvious BI strategy and vision			
2. Project management			
3. Business requirements identification			
4. Business readiness assessment			
5. BI performance assessment			
6. Change management			
7. Establishing BI alignment with business goals			
8. Developing and sharing deployment plan			
9. Training users and managers			
10. Planning and architecture			
11. Management support			
12. Organizational cooperation in BI implementation			
13. IT support for BI			
14. Creating comprehensive communication plan			
15. Creating data resources and quality of source data			
16. Creating the BI program prototype			
17. BI program repetitive development			
18. Installing and integrating the BI program			
19. BI system testing			
20. BI system support and maintenance			

BIOGRAPHIES

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